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## (54) Closed wound suction apparatus

(57) A closed wound suction apparatus comprises a housing, within which there is accommodated a microprocessor controlled battery powered suction pump, and a detachable drainage container arranged to be evacuated by the suction pump so as to apply a suction pressure to a drainage tube embedded in a closed postoperative wound. The suction pressure can be set by the surgeon and is monitored by a pressure sensor which reports to the pump control to determine operation of the pump in accordance with a predetermined set routine. Other controls that can be provided can monitor the volume of exudate in the container and/or the flow rate of exudate into the container. The container is preferably disposable and has self-sealing ports for connection to the vacuum pump and to the drainage tube.

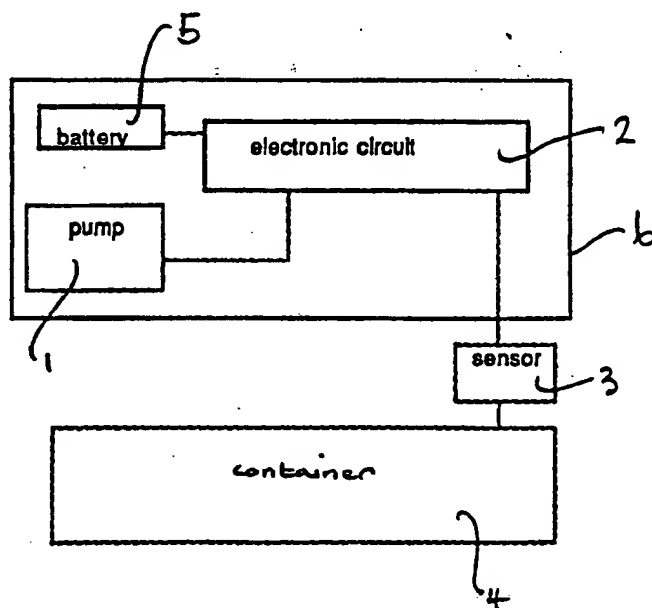


FIG 3

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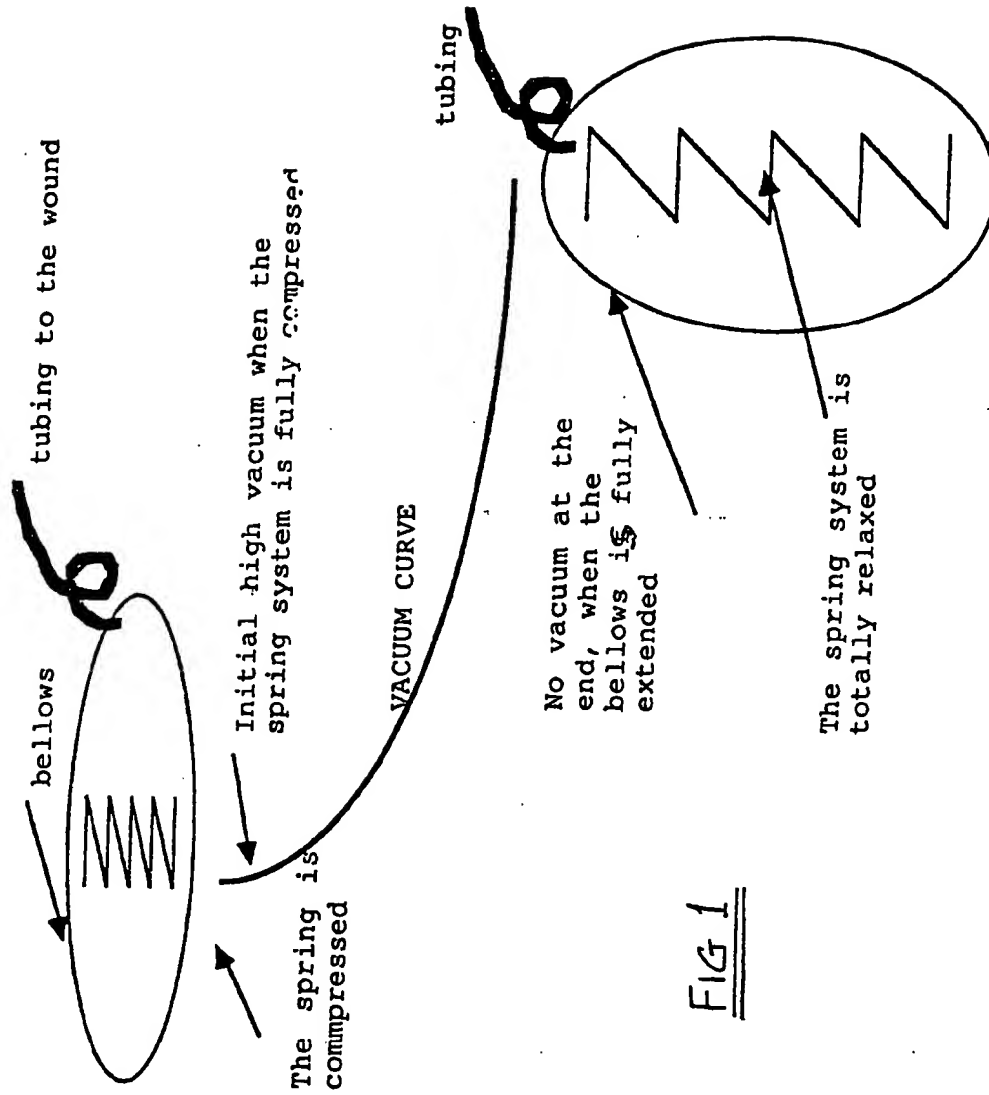
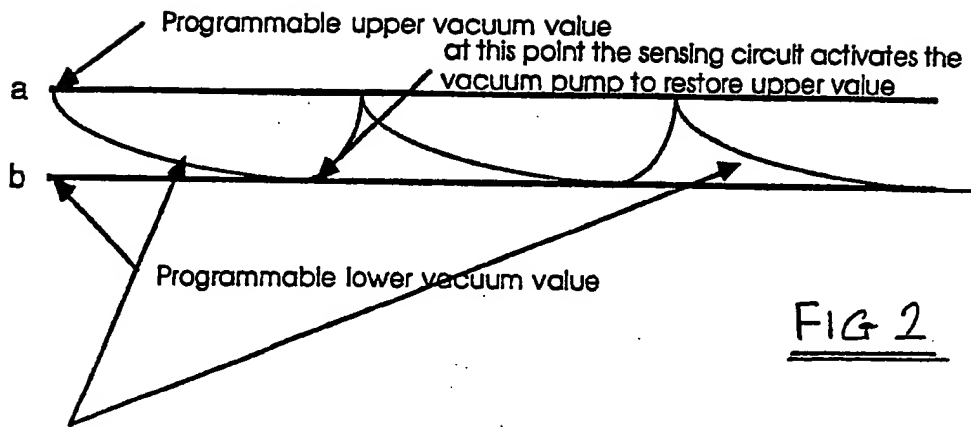


FIG 1



Vacuum curves behaviour, within a pre-programmed working window (a-b)

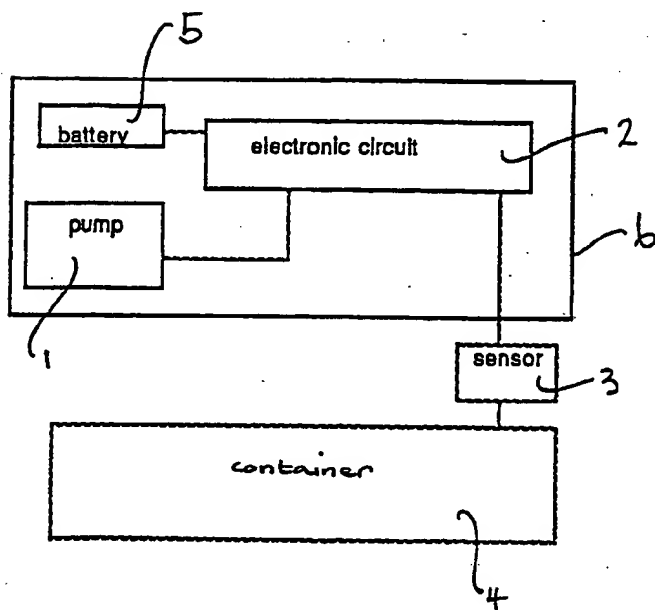
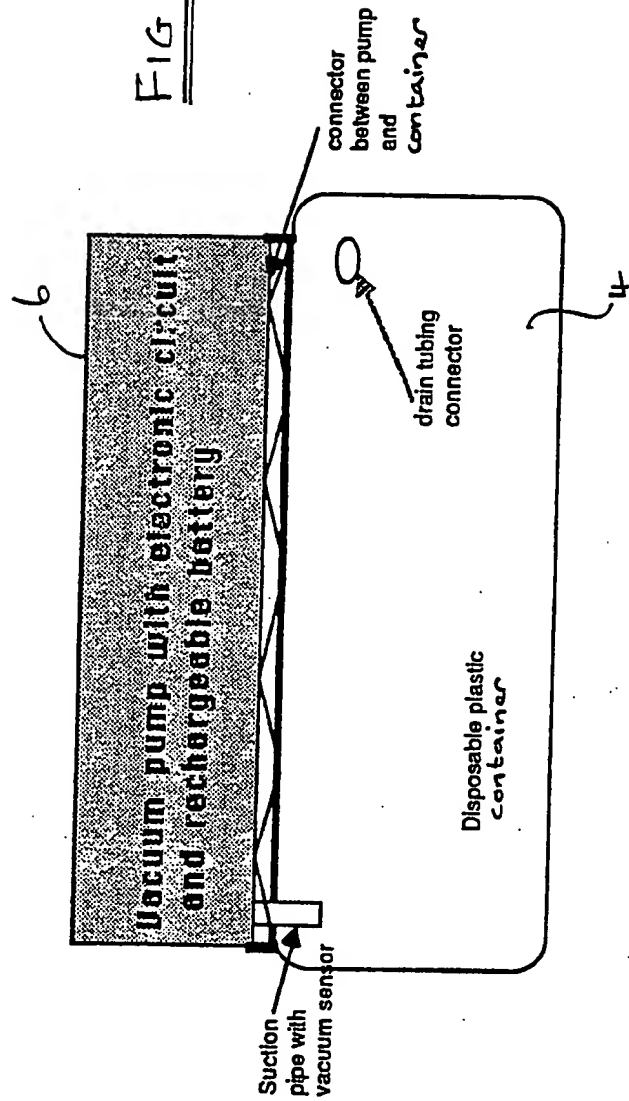


FIG 4



## CLOSED WOUND SUCTION APPARATUS

### Field of the Invention:

This invention concerns improvements in and relating to closed wound suction apparatus for use in  
5 effecting proper drainage of a postoperative wound.

### Background of the Invention:

Closed wound suction systems are known in which the suction that is applied to a drain tube inserted into a closed wound is achieved by means of a spring-  
10 loaded bellows device which is manually compressed before attachment to the drain tube and develops an internal suction pressure when the manual compression is released and the spring seeks to resile. One such closed wound suction system is the MaxiVac<sup>TM</sup> system  
15 that is available from Med General Laboratories Ltd. of Shannon Industrial Estate, Co.Clare, Ireland; this system aids in the maintenance of proper drainage of postoperative accumulation of serosanguineous fluid, purulent material and tissue debris in a wound, and at  
20 the same time decreases risk of infection, promotes primary wound healing and promotes the healing process by improving readaptation of tissue layers.

In common with other known closed wound suction

systems utilizing a spring-loaded bellows, the MaxiVac<sup>TM</sup> system suffers from the disadvantage that the suction that is produced by the bellows is at a maximum when first established and reduces  
5 thereafter. This causes uneven drainage of the wound, strong at the beginning and nil subsequently, which can give rise to clogging of the drainage tube. Additionally the vacuum that is generated cannot readily be modulated to the size and extent of the  
10 wound.

Objects and Summary of the Invention:

The principal object of the present invention is the provision of a closed wound suction apparatus which is not susceptible to the abovementioned  
15 disadvantages of known systems.

Another object of the present invention is to provide a closed wound suction apparatus enabling the suction pressure to be predetermined and maintained within set limits throughout a drainage period, and  
20 advantageously also enabling drainage progress to be monitored.

The above and other objects of the present invention are achieved by provision of a closed wound suction apparatus comprising an electrically operated  
25 vacuum pump coupled to a preferably disposable drainage collector coupled in turn to the wound

drainage tube, and wherein means are provided for monitoring and controlling the suction pressure in the drainage collector.

The apparatus according to the invention provides significant advantages in that the suction applied to a wound can be set by the surgeon, not only initially but also subsequently as healing progresses, and will thereafter be maintained so minimizing the need for constant progress checking and nurse intervention. Cost advantages may also be expected in that whilst the vacuum pump and associated controls are relatively expensive, the disposable drainage collector may be significantly less expensive than the bellows devices of such as the MaxiVac<sup>TM</sup> aforementioned so that over a period of time significant cost reductions may result.

The invention will best be understood from consideration of the following detailed description of an exemplary embodiment that is given with reference to the accompanying drawings.

**Brief Description of the Drawings:**

Figure 1 is a schematic showing of the variation in suction pressure that is achieved with a prior art device employing a spring-loaded bellows;

Figure 2 is a schematic showing of the suction pressure obtainable in accordance with the present invention;

Figure 3 is a block diagram showing of an exemplary embodiment of the present invention; and

Figure 4 is a general schematic showing of the embodiment.

5 Detailed Description of the Embodiment:

As has been explained in the foregoing, Figure 1 shows that the prior art spring-loaded bellows system provides an initial high vacuum level which reduces to zero over a period of time as the spring system of the bellows relaxes. The disadvantages of such prior art systems have been previously explained herein.

Figure 2 shows schematically how a closed wound suction apparatus may be programmed to operate within upper and lower vacuum values, with the electrically operated vacuum pump being switched on when the suction falls to the lower limit and being switched off when the suction rises to the upper limit. The difference between the upper and lower values can be set as desired and can even be reduced to zero or arranged to vary as a function of lapsed time.

Figure 3 is a schematic showing of an embodiment of the invention which comprises a battery operated miniature electric pump 1 coupled to an electronic circuit 2 which is arranged to be responsive to the condition of a pressure sensor 3 for controlling the pump operation within predetermined operator-set



levels. The pump 1 is coupled to a disposable drainage container 4 for determining the suction pressure therein, and the sensor 3 monitors the vacuum in the container 4. The container 4 in use is coupled  
5 to the wound drainage tube to receive substances drained from the wound. As shown in Figure 4 the pump 1 and associated electronic circuitry 2 and the battery 5 may be housed in a housing 6 having a suction pipe 7 and arranged to releasably couple with  
10 a disposable plastics container 4.

As has been previously stated herein, the apparatus according to the invention enables a customized vacuum to be set by the surgeon and will then automatically maintain such set vacuum, within  
15 predetermined and adjustable limits and optionally for a time period determined by the surgeon or dependent upon the rate of drainage from the wound that is achieved. Modern electronics and microprocessor facilities could if desired be utilized not only for  
20 control of the pump but also to monitor other sensors, such as sensors responsive to the quantity of drainage fluid in the container 4 and/or the rate of flow of drainage fluid, and to operate indicators and/or alarms in response thereto. The disposable drainage  
25 container 4 will ideally include self-sealing ports for connection to the suction pipe of the apparatus

and to the wound drainage tube so as to avoid leakage of possibly hazardous substances from a used drainage container awaiting incineration.

Monitoring of exudate volume and/or flow rate could be effected in a variety of different ways per se known in the art of liquid volume and flow monitoring. Non-contact methods are to be preferred for avoidance of risk of cross-contamination which could arise if, for example, re-usable probes were utilized for liquid level sensing. One preferred way of monitoring exudate volume and/or flow rate would be as a function of pump operation; the more frequently the pump has to be operated to maintain a set suction pressure the higher must be the exudate flow rate, and the integrated pump action likewise is an indicator of exudate volume. Where a re-usable drainage container, formed of glass or other autoclavable material for example, was used the exudate level within the container could be monitored by provision of sensor electrodes within the container, for example disposed on the container wall, or by optical or other techniques and the flow rate would be proportional to the rate of change of the level. Similar techniques per se known might be incorporated to enable the nature of the exudate to be monitored, for example as a function of its electrical conductivity.

The present invention thus provides a closed wound suction apparatus whereby a positive and constant suction pressure may be maintained by use of an electronically controlled vacuum pump coupled with  
5 an intelligent sensor programmable to the requirements of the particular postoperative condition being treated as determined by the surgeon. By use of microprocessor technology not only can the wound drainage program be set by the surgeon as required,  
10 but also the progress of wound drainage can be monitored to monitor exudate volume, flow and/or quality. The exudate container can be disposable and intended only to be used once in which case it should desirably include self-sealing ports, or can be re-  
15 sterilizable and re-usable.

CLAIMS:

1. A closed wound suction apparatus comprising an electrically operated vacuum pump, a drainage container coupled to the pump, a drainage tube coupled  
5 to the container and connectable into a wound to be drained, and a pressure sensor responsive to the suction pressure in the container for controlling the pump operation.
2. An apparatus as claimed in claim 1 wherein the  
10 vacuum pump is battery operated.
3. An apparatus as claimed in claim 1 or 2 wherein control means is provided enabling the operating suction pressure of the container to be set by an operator.
- 15 4. An apparatus as claimed in any preceding claim and including one or more further sensors responsive to fluid flow into said container.
5. An apparatus as claimed in any preceding claim wherein the container is disposable.

6. An apparatus as claimed in claim 5 wherein the container is self-sealing.

7. A closed wound suction apparatus substantially as herein described with reference to Figures 2,3 and 4  
5 of the accompanying drawings.